CLAIMS:

1. An optical scanning device for scanning optical record carriers having information layers at different information layer depths within the carrier, the optical record carriers including a first optical record carrier (3') having an information layer (2') at a first information layer depth $d_1$, a second optical record carrier (3'') having an information layer (2'') at a second information layer depth $d_2$ and a third optical record carrier (3''') having an information layer (2''') at a third information layer depth $d_3$, wherein $d_3 < d_2 < d_1$,

the scanning device including a radiation source system (7) for producing first, second and third radiation beams (4'; 4''; 4'''), for scanning said first, second and third record carriers (3'; 3''; 3'''), respectively, the device including a diffraction structure (48) introducing first, second and third, different, wavefront modifications into at least part of the first, second and third, radiation beams, respectively,

the diffraction structure being arranged to operate at selected diffraction orders $m_1$, $m_2$, $m_3$, for the first, second and third radiation beams, respectively, characterised in that the diffraction structure is arranged such that the following relation holds:

$$-1 < \frac{(m_3 - m_2)}{(m_2 - m_1)} - \frac{(d_3 - d_2)}{(d_2 - d_1)} < 1$$

2. An optical scanning device according to claim 1, wherein the diffraction structure (48) is arranged such that the following relation holds:

$$-\frac{1}{2} < \frac{(m_3 - m_2)}{(m_2 - m_1)} - \frac{(d_3 - d_2)}{(d_2 - d_1)} < \frac{1}{2}$$

3. An optical scanning device according to claim 1 or 2, wherein said optical scanning device has an optical axis (OA) and said diffraction structure (48) comprises a plurality of annular protrusions (50) arranged concentrically about said optical axis.

4. An optical scanning device according to claim 1, 2 or 3, wherein each said protrusion (50) has a stepped profile, each protrusion including a plurality of steps having different heights ($h_1$, $h_2$, $h_3$).

5. An optical scanning device according to any preceding claim, wherein said optical scanning device comprises an adaptation structure (40) arranged to introduce a non-diffraction adaptation component into each radiation beam, wherein said adaptation component is arranged to introduce spherical aberration.

6. An optical scanning device according to claim 5, wherein said adaptation structure provides a face (46) which is substantially aspherical.

7. An optical scanning device according to claim 5 or 6, wherein said diffraction structure (48) is combined with said adaptation structure (40).

8. An optical scanning device according to any preceding claim, wherein said optical scanning device has an optical axis (OA) and comprises a non-periodic phase structure arranged to introduce a non-periodic phase component into each radiation beam, wherein said non-periodic phase structure comprises a plurality of radial zones (114; 116; 118) arranged concentrically about said optical axis (OA) and having a non-periodic radial profile (107).

9. An optical scanning device according to claim 8, wherein said non-periodic phase structure is combined with said diffraction structure (48).

10. An optical scanning device according to any preceding claim, wherein the selected diffraction order $m_1$ for the first radiation beam is a positive order, the selected diffraction order $m_2$ for the second radiation beam is a zeroth order and the selected diffraction order $m_3$ for the third radiation beam is a negative order.

11. An optical scanning device according to any preceding claim, wherein each radiation beam has a predetermined wavelength ($\lambda_1$; $\lambda_2$; $\lambda_3$), wherein the wavelength of said third radiation beam is shorter than the wavelength of said second radiation beam and the wavelength of said second radiation beam is shorter than said first radiation beam.

12. An optical scanning device according to claim 11, wherein said predetermined wavelength of said first, second and third radiation beam is approximately 785, 650 and 405 nanometres, respectively.

13. An optical scanning device according to any preceding claim, wherein said first, second and third information layer depths $d_1$, $d_2$, $d_3$ are approximately 1.2, 0.6 and 0.1 millimetres, respectively.

14. An optical system for introducing first, second and third, different, wavefront modifications into at least part of first, second and third, radiation beams (4'; 4''; 4'''), respectively,

each said radiation beam having a different predetermined wavelength ($\lambda_1$; $\lambda_2$; $\lambda_3$), the wavelength of said third radiation beam being shorter than the wavelength of both said first and said second radiation beam,

wherein said optical system comprises a diffraction structure (48) having a profile which varies in steps which are arranged to provide selected diffraction components in said wavefront modifications, the selected diffraction component of said first wavefront modification being a diffraction component of a non-zero order,

characterised in that:

i) the diffraction structure is arranged such that the selected diffraction component of said third wavefront modification is a diffraction component of a non-zero order; and in that

ii) the steps of the profile of the diffraction structure are arranged to introduce into said second radiation beam phase changes, each phase change, modulo $2\pi$, being substantially equal to each other phase change.

15. An optical system according to claim 14, wherein said system includes a lens (32) for focusing each of said first, second and third radiation beams (4'; 4''; 4''').

16. An optical system according to claim 14 or 15, wherein said optical system has an optical axis (OA) and said diffraction structure (48) comprises a plurality of annular protrusions (50) arranged concentrically about said optical axis.

17. An optical system according to claim 16, wherein each said protrusion (50) has a stepped profile, each protrusion including a plurality of steps (52; 54; 56) having different heights ($h_1$; $h_2$; $h_3$).

18. An optical system according to any preceding claim, wherein each wavefront modification includes a non-diffraction adaptation component and said optical system comprises an adaptation structure (40) arranged to provide said adaptation component, wherein said adaptation component is arranged to introduce spherical aberration.

19. An optical system according to claim 18, wherein said adaptation structure (40) provides a face (46) which is substantially aspherical.

20. An optical system according to claim 18 or 19, wherein said diffraction structure (48) is combined with said adaptation structure (40).

21. An optical system according to any preceding claim, wherein each wavefront modification includes a non-periodic phase component and said optical system comprises a non-periodic phase structure arranged to provide said non-periodic phase component, wherein said non-periodic phase structure comprises a plurality of radial zones (114; 116; 118) arranged concentrically about said optical axis (OA) and having a non-periodic radial profile (107).

22. An optical system according to claim 21, wherein said non-periodic phase structure is combined with said diffraction structure (48).

23. An optical system according to any preceding claim, wherein said diffraction component of said first wavefront modification is a diffraction component of a positive order and said diffraction component of said third wavefront modification is a diffraction component of a negative order.

24. An optical system according to any preceding claim, wherein the wavelength of said second radiation beam is shorter than the wavelength of said first radiation beam.

25. An optical system according to claim 24, wherein said predetermined wavelength of said first, second and third radiation beam is approximately 785, 650 and 405 nanometres, respectively.

26. An optical scanning device for scanning a first, second and third, different, optical record carrier (3'; 3''; 3''') with a first, second and third, different, radiation beam (4'; 4''; 4'''), respectively,

each radiation beam having a different predetermined wavelength ($\lambda_1$; $\lambda_2$; $\lambda_3$), the wavelength of said third radiation beam being shorter than the wavelength of both said first and said second radiation beam,

said optical scanning device comprising an optical system (8) according to any of claims 14 to 25.

27. An optical scanning device according to claim 13, wherein the optical system is arranged to focus said first, second and third radiation beams (4'; 4''; 4''') to a desired focal point on said first, second and third optical record carriers (3'; 3''; 3'''), respectively.

28. An optical scanning device according to claim 26 or 27, wherein each of said first, second and third optical record carriers (3'; 3''; 3''') have an information layer at first, second and third information layer depths $d_1$, $d_2$, $d_3$, of approximately 1.2, 0.6 and 0.1 millimetres, respectively.

29. An optical system for introducing first, second and third, different, wavefront modifications into at least part of first, second and third, radiation beams (4'; 4''; 4'''), respectively,

each said radiation beam having a different predetermined wavelength ($\lambda_1$; $\lambda_2$; $\lambda_3$), the wavelength of said third radiation beam being shorter than the wavelength of both said first and said second radiation beam,

wherein said optical system comprises a diffraction structure (48) having a profile which varies in steps which are arranged to provide selected diffraction components in said wavefront modifications, the selected diffraction component of said first wavefront modification being a diffraction component of a non-zero order,

characterised in that:

i) the diffraction structure is arranged such that the selected diffraction

component of said third wavefront modification is a diffraction component of a non-zero order; and in that

ii) the steps of the profile of the diffraction structure are arranged such that the selected diffraction component of said second wavefront modification is a diffraction component of a zero order.